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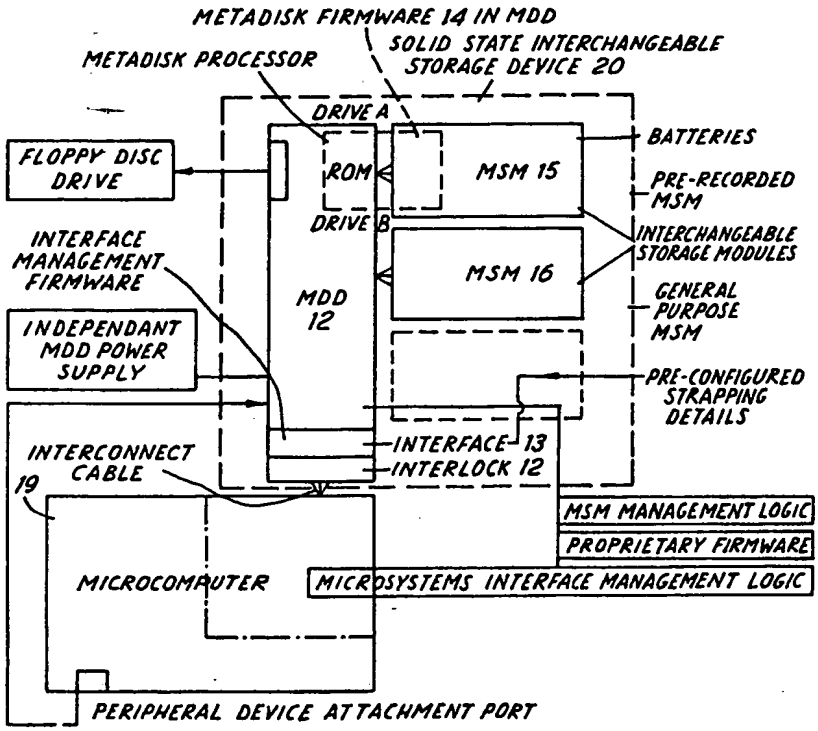
(71) Applicant
John Richard Mumford,
Woodstock, The Orchard, Ewhurst Road, Cranleigh,
Surrey GU6 7EB

(72) Inventor
John Richard Mumford

(74) Agent and/or Address for Service
Reginald W Barker & Co,
13 Charterhouse Square, London EC1M 6BA

(54) Interchangeable solid state memory device

(57) An interchangeable solid state data storage device 20 for a microcomputer or microprocessor comprising a semi-conductor storage module 15 or 16 with a plurality of electrically writable and/or readable storage areas, an internal battery 10 or 11 supplying said storage areas, and a support and interface device 13 whereby said storage medium appears as conventional magnetic disk storage.



The drawings originally filed were informal and the print here reproduced is taken from later filed formal copies.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1982.

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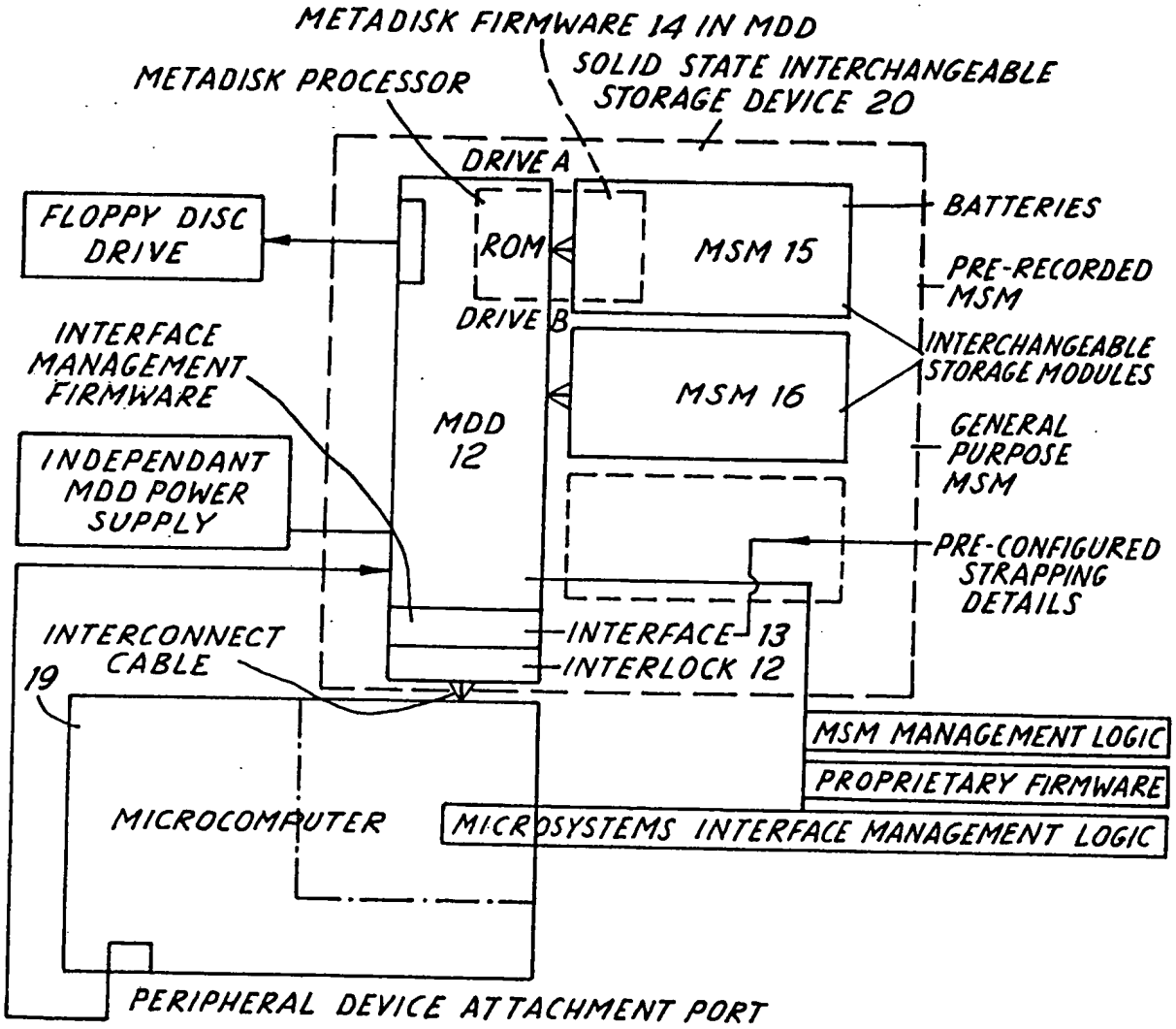

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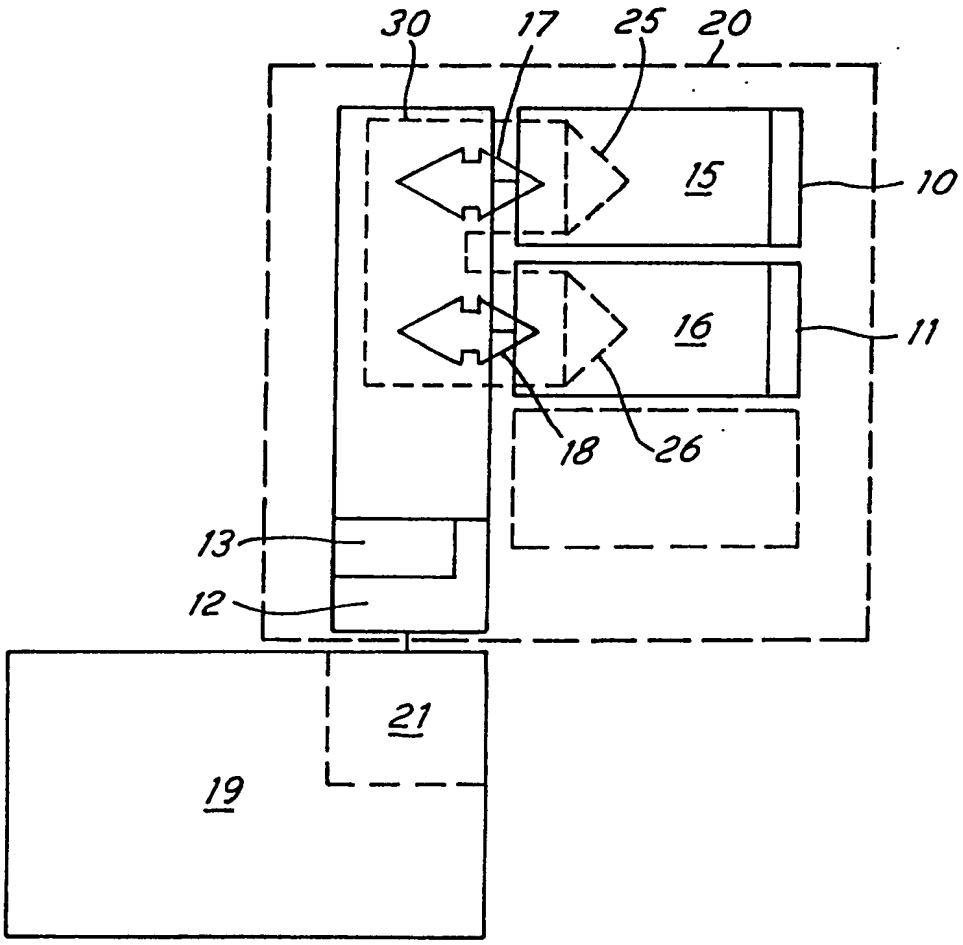

SPECIFICATION

Interchangeable solid state memory device

Ths invention relates to solid state data storage devices and is particularly, but not exclusively, concerned with interchangeable solid state storage devices compatible with, or to replace, conventional floppy (or flexible) or even hard disk storage, i.e. the disk drives and disk storage medium of proprietary microcomputer systems and more generally for compatibility or integration with microprocessors (and their associated operating systems) upon which such microcomputers are typically based.

Floppy disk drive storage and more widely magnetic storage mediums (including diverse technologies such as magnetic tapes and magnetic bubble memories) are fairly well developed art, particularly in microcomputer applications, but disks in particular, although widely used, have limitations of physical size, vulnerability to damage and long term deterioration and require precision electromechanical drive mechanisms and read/write heads. As a mass (data) storage medium, with sizes typically 3.5", 5" and 8", disks typically range from a few hundred K Bytes (KB) up to 1–1.5MB or so per floppy disk and up to several tens of MB for hard disks.

Also known in microcomputers and in association with or even incorporation in microprocessors, are internal solid state memory devices, typically variants of ROM's (read only memories) and RAM's (random access memories) for temporary (i.e. during machine run time and under power) storage of utility (e.g. operating system) program data and specific applications (or use) programs and temporary storage of processing data.

However, in keeping with the microprocessor processing power, such solid state storage devices are generally limited in storage capacity and are not intended to replace or substitute for the secondary mass storage facility typically afforded by a flexible disk and/or hard disk drive. Moreover they cannot be removed without loss of data and even risk of physical damage (particularly in the case of soldered connections.

According to one aspect of the invention there is provided an interchangeable solid state data storage device for a microcomputer or microprocessor comprising a semi-conductor storage module with a plurality of electrically writable and/or readable storage areas, an internal battery supplying said storage areas, and a support and interface device between said storage modules whereby said storage medium appears as conventional magnetic disk storage.

According to another aspect of the invention there is provided a magnetic disk storage simulator comprising a solid state semiconductor storage device with a plurality of storage areas, one or more of said storage areas storing an operating program whereby said storage device interfaces with a microcomputer or microprocessor and simulates a magnetic disk storage device.

According to a further aspect of the invention there is provided a microcomputer or microprocessor secondary or supplementary electronic data mass storage device comprising an interchangeable solid state semi-conductor block storage module with a plurality of separate and distinct allotted storage areas, including a processing data storage area, an applications program storage area for pre-recorded executable program data, a utility program area for pre-recorded executable operating system data, some of said storage areas, being permanent or electronically non-rewritable and some of said storage areas being electronically re-writable, all said storage areas being readable, an internal battery or power supply for at least some of said storage areas, a support and interface device between said storage module and a microcomputer or microprocessor said support and interface device and said storage modules incorporating operational utility firmware, whereby said secondary storage medium appears as a conventional magnetic disk storage system.

Thus, the present invention is concerned to achieve an alternative mass secondary storage device for a microprocessor or microcomputer and one which may be presented as a plug-in module with either an independent or self-contained power supply or drawing power from the microcomputer internal power supply.

There now follows a description of a particular embodiment of the invention, by way of example only, with reference to the accompanying drawings which show, in two corresponding respectively annotated and non-annotated block schematic forms, the layout of an interchangeable solid state data storage device.

Referring to the drawings, a microcomputer solid-state, or semi-conductor data storage device 20 comprises a drive unit 12 and a plurality of storage modules 15, 16 of which two are depicted.

The drive 12 has an interface 13 for an otherwise conventional microcomputer 19, together with a safety or security interlock 12 to inhibit removal or disconnection of the storage device 20 from the microcomputer under data transfer conditions.

The drive 12 effectively replaces for supplementary or secondary data storage a conventional disk drive unit 21 indicated as incorporated within the microcomputer 19 itself, although it might constitute a separate unit connected thereto with standardised interfaces and leads.

Each storage module 15, 16 incorporates 'firmware' or non-rewritable software, typically

in RAM supported by internal re-chargeable batteries 11, 12 respectively, controlling the storage utilisation and operation in conjunction with complementary 'firmware', conveniently stored in ROM, in the drive 12. This firmware may be utilised to afford security against unauthorised use of programs loaded in the storage modules by exchanging unique codes with the drive 12 so that the storage modules cannot be used in other unauthorised drives or a warning message is generated.

Independent reserve battery storage is incorporated in each storage module 15, 16 (and this is crucial to the interchangeability of the modules whilst retaining data storage as discussed later) and the drive 12 may also have an independent power supply or receive power through an interconnect cable, possibly also carrying data communication from a peripheral device port of the microcomputer.

The drive 12 performs a generally equivalent function in relation to the interchangeable storage modules as does a conventional floppy (or even hard) disk drive unit in relation to a floppy (or hard) disk, and indeed the interface 13 may be arranged to make the drive 20 appear to the microcomputer 19 as just such a conventional disk storage device. This is essentially interfacing at a lower level of a microcomputer operating system, but the device 20 admits of savings in components, cost and operating time by interfacing at a higher level 'closer' to the operation of the microprocessor upon which the microcomputer 19 is based.

The storage modules 15, 16 are conveniently in blocks of at least 256K Bytes and may be broadly of two kinds.

Firstly, loaded or pre-recorded with proprietary applications software, desirably incorporating a software protection facility as discussed previously, together with a proportion of available software area reserved for the firmware associated with running the module itself and the residual storage area for routine processing operations.

Secondly, a more general purpose storage module in which most of the storage capacity is available for ongoing processing operations whilst preserving a residual storage area for operational firmware.

Each storage module relies upon RAM actively supported by its internal (battery) power supply—which is conveniently re-chargeable automatically upon usage of the module.

The drive 12 incorporates a microprocessor of its own and which, with its associates firmware 30 essentially supports in stand-alone format or more directly integrated with a microprocessor system and interfaces the interchangeable storage modules 15, 16 and effectively makes the entire storage device 20 interchangeable and/or transportable by providing basic functions such as, system physical support, power supply, interface management to a wide range of microcomputers, proprietary application software protection, management of the storage modules themselves and support of or compatibility with conventional disk drives.

The term 'drive' is used herein to embrace the support and inerface functions and to reflect the equivalence or parallel with a disk drive in relation to disk storage.

The drive 12 conveniently accommodates 2 of more storage modules 15, 16, e.g. through plug and socket interfaces 17, 18 desirably incorporating interlocks 25, 26 inhibiting the power supply (i.e. battery recharging, etc.) connection during insertion and removal of storage modules and also desirably inhibiting removal during active data transfer. A physical wiring interconnection between the drive 12 and the microcomputer 19 and provision for 'strapping' connections between circuit board elements of the drive itself may allow for adaption to suit particular physical interface requirements.

The storage device 20 as a whole may be used either with a microcomputer that already incorporates or supports supplementary or secondary disk storage by replacing or supplementing such storage or with a microcomputer that has no such existing facility, in which latter case appropriate additional hardware would be incorporated in the drive 12.

Other aspects of the invention are outlined in the following appendix;

SECTION 2 INTRODUCTION

2.1 BACKGROUND CONSIDERATIONS

Secondary Storage, for purposes of Micro-Computer Systems, can be defined as electrically writeable and readable storage which is used as a medium for the retention and/or transfer of information (Data and Programs).

Secondary storage is typified on existing Micro-Computer Systems by:

Magnetic Tape
(Normally in thr form of cassettes)
Flexible Discs
Winchester Technology Discs
Magnetic Bubble Memories

Magnetic Tape and Flexible Discs are further characterised by being subdivided into a "Drive" (eg the Tape Recorder or the Flexible Disc Drive Unit) and a "Medium" (eg the Tape Cassette or the Flexible Disc) which may be detached from the Drive and used to transport information.

Information is written onto the surface by moving the medium past a Read/Write head (either linearly for tape or by rotation for F/Disc) and using the head to alter the magnetic characteristics of the surface of the Medium. Information is read from the medium by using the head to detect these magnetic changes.

2.2 BASIC ELEMENTS OF THE METADISK

SYSTEM

A METADISK "Drive" (MDD) may be considered as being a "Silicon Analogue" of a Flexible Disc Drive (FDD) (or Tape Recorder) and a METADISK Storage Module (MSM) is a "Silicon Analogue" of the Flexible Disc Medium (or Cassette). The METADISK SYSTEM Firmware (MSF) is divided between read only memory (ROM) located within the MDD and a reserved area on the MSM. The METADISK Technique completely replaces both the F/Disc drive and the F/Disc itself.

A METADISK Secondary Storage Unit can be presented to the Micro-Computer at the Operating System level exactly as though it were a F/Disc Storage unit except, of course, that it operates faster and completely without noise or moving parts. Other forms of presentation may be supplied such as Magnetic Tape Drive, Micro-Computer standard I/O port, DMA and so on.

The METADISK Information Storage Medium carries out the functions of the F/Disc Information Storage Medium except that it is smaller and much less vulnerable to loss of data through damage of the Medium itself due to mechanical wear.

SECTION 3 THE METADISK STORAGE MEDIUM (MSM)

3.1 BASIC MSM CHARACTERISTICS

An MSM is a block of semi-conductor memory which is supplied as a plug-in module to be supported by the METADISK Drive (MDD). It embodies batteries which ensure that the information stored on the MSM is retained when the module is removed from the MDD. These batteries are of a re-chargeable type and are recharged every time the MSM is loaded into an MDD.

The initial capacity of an MSM of any type will be 256 KBytes and later developments will lead to the provision of MSM's with much larger capacities.

Two basic types of MSM will be provided as described in sections 3.2 and 3.3 below.

3.2 PRE-RECORDED MSM's

Pre-Recorded MSM's are used for the distribution of proprietary application software and incorporate the software protection feature outlined in section 4 below.

A proportion of the available storage space is used to store the application software and elements of the METADISK System Firmware, the remainder is made available for normal processing operations.

3.3 GENERAL PURPOSE MSM's

The General Purpose MSM is exactly the same as the Pre-Recorded MSM except that almost all of the storage capacity of the General Purpose MSM is made available for normal processing operations. A small amount is reserved to ensure that copied application software can be protected, and to provide some of the other features of the METADISK System.

SECTION 4 THE METADISK DRIVE MODULE (MDD)

4.1 BASIC FUNCTIONS

The Basic Functions of the METADISK Drive (MDD) are as follows:–

* System Physical Support
* Power Supply
* Management of the Interface to a wide range of Micro-Computer Systems
* Proprietary Application Software Protection
* Management of the METADISK Storage Medium (MSM)
* Support of Conventional F/Disc Drives

MDD Modules will be supplied either in Stand-Alone Format or be designed in specialised formats suitable for direct integration into the structure of Micro-Processing Systems.

4.2 SYSTEM PHYSICAL SUPPORT AND POWER SUPPLY

The basic structure of the MDD will be designed to accommodate 2 (or 4) MSM Units irrespective of the overall format. The MSM support units will normally be designated Drive A and Drive B (or A, B, C, D). Physical interlocks will ensure that MDD power to the MSM is removed during the processes of insertion and withdrawal. Interlocks will also prevent the physical removal of the MSM's when files are open on the MSM (This latter function may be achieved using the MSM management firmware [qv]).

In its normal operational configuration the MDD will be loaded with a Pre-Recorded MSM in Drive A and a General Purpose MSM in Drive B.

Stand-Alone Format General

The MDD will support the Micro-System Interface Management Logic, the MSM Management Logic and the Proprietary Firmware associated with these two functions and their inter-operation. The MDD to Micro-Processor interconnect cable and its termination on the printed wiring board, on which the MDD internal electronic and interconnect components may be supported, will be designed to allow for the insertion of pre-configured strapping details to match the interface of the Micro-Processing System to the standardised interface on the Processor side of the MDD. Non-integrated MDD's will be equipped with an independent power supply.

Stand-Alone Format Specific

This is a variation of the Stand-Alone MDD in which the power may be supplied over the interconnect cable to the Micro-Processor System. The option may be implemented to interface the MDD via some other peripheral device attachment port to the Micro-Processor

System.

Integrated Format

Here the MDD is supplied in a customised format suitable for integration directly into the structure of the Micro-Processing System to be served.

The Hardware and Firmware provided are designed to allow the METADISK System to be "built into" the Micro-Processing System and to be supported at the interface level required, and to be powered by the Micro-Processing System.

4.3 MICRO-SYSTEMS INTERFACE AND INTERFACE MANAGEMENT

Stand-Alone General Format

In the general Stand-Alone Format the MDD will normally be presented to the Micro-Processing System as though it were the Logical Elements of a conventional Flexible Disc Drive (FDD). The signals and Data normally passed by the Micro-Processor to a conventional FDD are used, under the control of the MDD Interface Management Firmware, to pass data from the Micro-processor via the MSM Management Firmware to the storage incorporated in the MSM module. Similarly, Data retrieved from the MSM Module by the MSM management firmware is passed to the Micro-Processor Interface Management Firmware for transmission back towards the Micro-Processor.

Specific Stand-Alone and Integrated Format

In any specific Format the option to interface the MDD to the Micro-processor at a different level (say direct onto an I/O Port or via DMA) may be provided.

4.4 PROPRIETARY APPLICATION SOFTWARE PROTECTION

The METADISK Secondary Storage Technique embodies facilities which allow for the use of Application Software, distributed on MSM's to be restricted to the MDD System on which it is first used.

The MSF, which is executed by the METADISK Processor, writes the MDD identity onto Pre-Recorded MSM the first time it is used by the MDD. When copies of the Application Software are made on General Purpose MSM's the MDD identify is carried across to the new MSM. When the Program is called the identity is compared before the loading of the Application Software to the Micro-Computer System is permitted by the MDD.

As an alternative the system can be used to display a "Piracy" Message in addition to the normal sign on message when a copy of the Application Software Package is used on another METADISK System. This would overcome the problem that the legitimate owner of a license to operate an Applications Package may need to use a Micro-Processing System other than his own from time to time.

4.5 METADISK STORAGE MEDIUM MANAGEMENT

The MSM is managed by part of the METADISK System Firmware (MSF) which forms part of the MDD Unit. At the fundamental level the available memory on either a Pre-Recorded or a General Purpose MSM will be treated as a single block which may be subdivided and used as any number of separate files. A basic MDD consists of 2 MSM Support Modules, however, MDD's may be interconnected to build up to as may virtual drive units as the operating system of the Micro-Processor System can support.

4.6 CONVENTIONAL F/DISC SUPPORT

As an option the MDD can be furnished with the necessary hardware and extension to its METADISK SYSTEM FIRMWARE (MSF) to allow conventional F/Disc Drives to be supported.

This option takes 2 forms:

The continued support of F/Disc Drives already supported by the attached Micro-Processor System.

The ability to support F/Disc Drives on Micro-Processor Systems on which no conventional F/Disc Drive support would normally be provided.

SECTION 5 METADISK SYSTEM FIRMWARE (MSF) AND UTILITY PROGRAMS

5.1 MSF MAIN FUNCTIONAL AREAS

MSF may be defined in the following functional areas:

METADISK Drive to Micro-Processor System Interface Management

This subsection of MSF operates entirely within the MDD and handles the interface between the MDD and the attached Micro-Processor System. It will itself be available in a set of options:

Standard Floppy Disc

In this mode MSF presents the MDD to the Micro-Computer System as though it were a conventional Floppy Disc System having a specific number of Drives (eg 16 Drives for the DRI CP/M Operating System). Thus, where the Micro-Computer System supports F/Disc of a "Standardised Type" this element of the MSF will enable the METADISK System to be used as a "plug compatible" replacement.

Specific Secondary Storage Support

Where Micro-Processor Systems have a specialised or specific methodology for the attachment of Secondary Storage the MSF will be designed to support that specific methodology.

METADISK Storage Module (MSM) Management

This subsection of MSF operates entirely within the MDD and handles the Pre-Recorded

and General Purpose METADISK Storage Modules. MSF detects whether a GP or a PR MSM has been loaded into a particular MSM support unit and uses the appropriate subsection of its own code to manage the MSM:

MSF for General Purpose MSM's

This element of MSF covers the whole process of storing data onto the General Purpose MSM and retrieving that data. Interfacing to the Micro-Computer System is via the Interface Management subsection of MSF. Some of the MSF code is stored in reserved areas on the GP MSM.

MSF for Pre-Recorded MSM's

This manages the PR MSM and also ensures that the Pre-Recorded Data is protected against accidental erasure or being overwritten. Proprietary Software protection code is shared between the MDD and the reserved areas of the PR MSM.

5.2 METADISK SYSTEM UTILITY PROGRAMS

Every METADISK System is shipped with at least 1 PR MSM containing the METADISK System Utility Program Set. These Utility Programs are designed to operate in the Micro-Processor System to which the METADISK System is to be attached. They are concerned with the basic housekeeping functions of the METADISK system itself:

MD VERIFY

This Program enables the function of every storage cell in any MSM to be checked and reported.

MD VERIFY/TRANSFER

This Program allows the faulty storage areas on an MSM to be bypassed and all readable data to be transferred to another MSM. A special marker is inserted into the File on the Target MSM to mark each bypassed cell.

MD FORMAT

This Program will erase all the data on an MSM except that which is within the Protected Area of a PR MSM or a GP MSM which has had Protected Areas Assigned using the MD PROTECT Program (QV).

MD PROTECT

This Program will enable Files on an MSM to be moved to within the boundaries of a Protected Area which will then be protected from the activities of the MD Format Utility and Utility Programs which form part of the Operating System of the attached Micro-Processing System. The UNPROTECT Element of this Utility will enable the Protect Feature to be rescinded. The Program will have no effect on the Protected Areas of PR MSM's.

MD COPY

This Program will enable the contents of any MSM loaded in MDD A to be copied to any other MDD.

CLAIMS

1. An interchangeable solid state data storage device for a microcomputer or microprocessor comprising a semi-conductor storage module with a plurality of electrically writable and/or readable storage areas, an internal battery supplying said storage areas, and a support and interface device between said storage modules whereby said storage medium appears as conventional magnetic disk storage.

2. A magnetic disk storage simulator device comprising a solid state semi-conductor storage device with a plurality of storage areas, one or more of said storage areas storing an operating program whereby said storage device interfaces with a microcomputer or microprocessor and simulates a magnetic disk storage device.

3. A microcomputer or microprocessor secondary or supplementary electronic data mass storage device comprising an interchangeable solid state semi-conductor block storage module with a plurality of separate and distinct allotted storage areas, including a processing data storage area, an applications program storage area for pre-recorded executable program data, a utility program area for pre-recorded executable operating system data, some of said storage areas, being permanent or electronically non-rewritable and some of said storage areas being electronically re-writable, all said storage areas being readable, an internal battery or power supply for at least some of said storage areas, a support and interface device between said storage module and a microcomputer or microprocessor said support and interface device and said storage modules incorporating operational utility firmware, whereby said secondary storage medium appears as a conventional magnetic disk storage system.

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